Formal models for component connectors

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We have seen that computer programming is an art, because it applies accumulated knowledge to the world, because it requires skill and ingenuity, and especially because it produces objects of beauty.

— Donald E. Knuth [65]

SUMMARY

The corner stone of all engineering disciplines is the principle of constructing complex systems out of building blocks according to well defined rules. In the paradigm of hardware design, for example, complex systems are obtained by composing interconnected, inherently parallel components, which can represent transistors, logic gates, functional components such as adders, or architectural components such as a processor. In this thesis we study *computer systems* according to the same principle. We study computer systems and their construction according to a component-based paradigm. In particular, we consider paradigms for component-based systems that provide a clean conceptual separation between *computation* and *interaction*, and as a result favour the reusability of individual (heterogenous) components and the dynamic interchangeability of components.

The research presented in this thesis builds upon a large body of existing knowledge from the field of coordination languages and models. In this field components are classified into two distinct classes: components that provide systems-specific functionality, and components that provide systems-independent interaction protocols, called *connectors*.

The main contributions of this thesis advance a prominent line of research pursued in recent years: that of developing compositional models for component connectors. In particular, it contributes by proposing two new compositional models for context-dependent connectors: *connector colouring* and *intentional automata*. The behaviour of context-dependent connectors permits to express notions of *dataflow priority* and *dataflow blocking* which are traditionally hard to model compositionally. Connector colouring and intentional automata models capture the behaviour of context dependent connectors compositionally.

Additionally, this thesis contributes a simulation and animation framework for connectors, called *connector animation*. The dataflow behaviour of a connector is simulated by means of visual animations. The visual animations are based on the connector colouring semantics. We define a formal refinement map from the dataflow behaviour prescribed by a colouring into an animation specification. Our main result here is that the composition of colourings carries over to refinement maps, meaning that whenever two colourings compose, we can compose the animation specifications that refine each colouring and obtain an animation specification that refines the composed colouring.